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No. 73

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USSR REPORT

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A FAST-RESPONSE CONTROLLER IN REACTOR SPACE-TIME DYNAMICS

AFANAS'YEV, A. M. and TORLIN, B. Z.

[Abstract] A quantitative estimate is made of the influence that the difference between large and infinite gain K in the signal conversion circuit between the sensor and the control rod actuating mechanisms has on the characteristics of the control process for an astatic local regulator that controls the spatial distribution of neutron flux in a reactor. The analysis is based on a one-group diffusion approximation with consideration of one group of delayed neutrons and one first-order internal feedback link with positive reactivity, disregarding the lifetime of the prompt neutrons. It is shown that values of ω are practically the same as ω_0 (corresponding to the limiting case $\varepsilon = (M/H)^2/K = 0$) over a wide range of K, i.e., the regulator can be considered fast-acting in the given range. The maximum discrepancy of about 17% between ω and ω_0 is observed at $K = 4.5 \cdot 10^{-2}$. At such a low gain, assuming a time constant of internal feedback $\tau = 30$ s, and neutron flux imbalance $\Delta\Phi/\Phi_0 = 3 \cdot 10^{-2}$, the rate of reactivity input by the control rod is no more than $6 \cdot 10^{-3}$ β/s, i.e., an order of magnitude lower than required by nuclear safety regulations. Stability may be either increased or decreased with increasing gain, depending on the relative placement of the sensor and the control rod. Figure 1; references: 7 Russian. [15-6610]

THE STATE OF THE ART AND FUTURE OUTLOOK IN TOKAMAK FUSION RESEARCH

KADOMTSEV, B. B., academician, and STRELKOV, V. S., doctor of physical and mathematical sciences

[Abstract] A brief survey is given of the development of tokamak research as one of the principal lines of attaining magnetic containment of plasma for purposes of controlled nuclear fusion. The first tokamak was developed 25 years ago in the USSR,

and there are now about 40 facilities of this type in the Soviet Union, the United States, Great Britain, France and West Germany. The basic principles of tokamak construction are reviewed, and data are given on what has been learned over 25 years in the areas of equilibrium and stability, thermal insulation, impurities and factors that limit containment time. The next step in tokamak research will be the development of large facilities to produce a plasma with parameters close to thermonuclear as the last stage in construction of the INTOR installation that will demonstrate the feasibility of a self-sustaining reaction with energy production by nuclear fusion. Such a facility is the T-15 tokamak at the Institute of Atomic Energy imeni I. V. Kurchatov. This is a circular tokamak without a diverter and with Nb_3Sn superconductive windings. Supplementary heating of the plasma is by injection of fast atoms and microwaves. The major radius of the torus is 2.4 m, the stabilizing field strength is 3.5 T, and the current in the plasma is 1.4 mA for a duration of 5 s. It is expected that these figures will be increased to 4.5 T and 2.3 mA after the first series of experiments. In 1979 the IAEA set up an international working group to study the feasibility of making a tokamak-based fusion reactor. A detailed report by this group reaches the conclusion that it should be possible within 10 years to build the INTOR international tokamak reactor. This facility will have a torus with major radius of 5.2 m and a stabilizing field of 5.5 T. Current in the plasma will be 6 mA at density of $1.4 \cdot 10^{14}$ cm^{-3} with ion and electron temperature of 10 keV. [23-6610]

UDC 621.3.013:621.313.12.004

A ONE-MACHINE HIGH-FREQUENCY EXCITATION SYSTEM FOR TVV-320-2 AND TVV-500-2 TURBO-
GENERATORS

NAUMOV, V. F., LUKASHEV, N. I., engineers, and SAVCHENKO, Ye. V., candidate of
technical sciences

[Abstract] The paper describes a one-machine high-frequency excitation system for
the TVV-320-2 and TVV-500-2 turbogenerators at the Slavyansk State Regional Electric
Power Plant. This system was developed as a result of redesigning the regular two-
machine excitation system with EPA-500 regulator. The installation includes an
auxiliary generator (exciter) of inductor type on a frequency of 500 Hz with a series
excitation winding and two independent excitation windings, a silicon diode rectifier,
an automatic field quenching unit with a circuit for protecting and shunting the
turbogenerator excitation winding, and an automatic excitation regulator. The pro-
posed system has increased the working reliability of the entire turbogenerator as
well as simplifying servicing. Tests and working experience with the one-machine
variant of the excitation system have shown that it meets existing requirements with
respect to technical and operational characteristics, places no restrictions on turbo-
generator operation, and can be recommended for extensive replacement of the two-
machine system now in use. Figures 4; references: 2 Russian.
[13-6610]

UDC [66.048.54:621.311.21]:62-19.002.238

IMPROVING THE WORKING RELIABILITY OF EVAPORATORS OF 300 MW POWER PLANTS

GOLUBEV, Ye. K., candidate of technical sciences, GLAZOV, Ye. Ye., YEGOROV, N. I.
and POPOV, V. P., engineers

[Abstract] The article describes modifications made in the I-250-2 evaporators on
the 300 MW generator units at Novocherkassk State Regional Electric Plant to increase
water treatment capacity. The height of the steam space was raised to 2.9 m by an
additional cylindrical insert. At the same time, the porosity of the steam-washing

plates was increased to 5.3%, and the distribution of condensate and feed water to the washing plates was improved. Tests showed that these modifications resulted in secondary steam satisfying the water makeup requirements of the power plant over a wide range of concentrate salt contents, steam loads and rates of change in the heating steam pressure due to variations in the load on the turbogenerator. Figures 4; references: 4 Russian.
[14-6610]

TOLUENE AS THE WORKING FLUID IN SOLAR STEAM-TURBINE UNITS

BEZRUCHKO, K. V., BELAN, N. V., GRILIKHES, V. A. and GRISHUTIN, M. M., Leningrad

[Abstract] Toluene is one of the most promising organic compounds for use as the working fluid in solar steam-turbine power plants. One of the most important properties is that the temperature of thermal dissolution of toluene (826 K) exceeds the critical temperature (593.96 K). This means that supercritical cycles can be realized in steam turbines using toluene as the working fluid, thus improving thermal efficiency. In addition, the low melting point of toluene (178.15 K) makes it suitable as a working fluid in solar power and cooling facilities designed for simultaneous production of mechanical (electrical) energy, heating and refrigeration. In this paper, the thermophysical properties of toluene are generalized, systematized and extrapolated into the region of higher temperatures. A table and empirical formulas are given showing experimental and extrapolated data on density, heat of vaporization, heat capacity, dynamic viscosity coefficient, coefficient of thermal conductivity, saturated vapor pressure, specific isobaric heat capacity of superheated vapor, surface tension and specific enthalpy as functions of temperature up to 590 K. The i-S diagram of toluene is given. It is pointed out that the saturation pressure at high saturation temperatures is low enough to make high-pressure steam turbines feasible, while the ratio between P_s and T_s is adequate to ensure a stable condensation process in surface condensers. Corrosion can be kept at a minimum by keeping the impurity content of the toluene at a low level. Figure 1; references: 13 Russian.
[2-6610]

A DEVICE FOR CONTROLLING RADIANT FLUX IN SOLAR INSTALLAT ONS

KHAKIMOV, R. A., ZAKHIDOV, R. A. and SIZOV, Yu. M., Central Technological Office for Planning and Design in Scientific Instrument Making, Uzbek SSR Academy of Sciences

[Abstract] This article describes regulation of radiant flux in large solar furnaces by a heliostat with shades and a concentrator with controllable orientation of facets. As the heliostat tracks the sun, the shades are fully opened so that the surface of the heliostat is totally exposed. When it is necessary to adjust the degree of transmission of radiant flux, fine adjustment drives are actuated that stretch the shades on tension-loaded rollers with continuous control from fully open to complete closure with only one facet left uncovered for tracking. Under emergency conditions, a rapid closing device can be actuated that snaps the shades to the closed position. Radiant flux control can also be realized by controlled orientation of individual facets in a composite concentrator over a wide range and over the entire surface of the concentrator. Radiant flux can be controlled remotely by setting some angle of any facet or group of facets depending on the required power at the focal spot with a step of 5-10 kW in a range of up to 1000 kW or even more. The initial position of the facets can be automatically reset within an accuracy of 1 angular minute. Figures 3; references 4: 3 Russian, 1 Western.
[2-6610]

COMBINED PRODUCTION OF HEAT AND COLD BY A SOLAR FACILITY WITH GLASS-COVERED SOLUTION HEATER AND REGENERATOR

KHANDURDYYEV, A., KAKABAYEV, A. and KURBANKULIYEV, Ch., Physicotechnical Institute, Turkmen SSR Academy of Sciences

[Abstract] An analysis of possible temperature conditions in an absorption solar refrigeration plant with glass-enclosed solution regenerator has shown that the salt-water solution to be regenerated can be heated in the glass-covered surface during the summer to 20-30°C above the temperature at the beginning of the regenerator. Since the cooling water in the absorber is heated mainly to 30°C, the authors consider the possibility of using a reflux heat exchanger for final heating of the absorber-cooling water by the solution. The proposed scheme for producing both heat and cold does not involve extensive modification of the conventional solar refrigeration facility with glass-covered solution regenerator. Partial return of the solution to the regenerator after the heat exchanger increases the intensity of evaporation of

the solution and raises the cooling capacity of the facility. The principal advantage of the proposed design is that the glass-enclosed regenerator can be used for providing hot water during the part of the year when air conditioning is not required. An equation is derived for calculating the specific heating and cooling capacity of the facility as a function of meteorological and other conditions. Energy performance is analyzed for typical working conditions. Figures 2; reference: 1 Russian.

[2-6610]

A HEAT TRANSFER DEVICE FOR SOLAR HEATING SYSTEMS

NASONOV, Ye. A. and BONDARENKO, Yu. I., Tashkent Regional Scientific Research Institute of Experimental Design of Housing and Public Facilities

[Abstract] The authors describe their "reverse thermosiphon" that transfers heat downward for a distance of several meters. The device contains an evaporator connected by a transport tubing section to a condenser on a lower level. Above the evaporator on the transport section is a condensate collector that is joined to the evaporator by a siphon. Above the collector is an auxiliary condenser. Above the auxiliary condenser is a displacement tank that is connected to the bottom of the main condenser by a length of tubing. The unit is hermetically sealed and evacuated, and a liquid heat transfer agent is charged into the lower part of the evaporator. When heat is applied to the evaporator, the liquid begins to evaporate and the vapor pressure displaces condensate from the transport section and the main condenser into the upper displacement tank. Vapor condenses with release of heat on the walls of the main condenser. The process of heat transfer from the evaporator to the main condenser continues until all available condensate has been evaporated. Then the vapor that has partly condensed on the surface of the auxiliary condenser reduces its pressure, and the condensate flows from the displacement tank into the main condenser, the transport section and the condensate collector. The siphon feeds the condensate to the evaporator, and the cycle repeats. Theoretical relations are given that define operation of the device, and experimental results are presented. Two designs are suggested for using the device in solar heating facilities. Figures 4; reference: 1 Russian.

[2-6610]

ANALYSIS OF PROBLEMS OF OPTIMIZING RELIABILITY OF ELECTRIC SUPPLY SYSTEMS

KHOLMSKIY, D. V., Kiev

[Abstract] Problems of optimizing the reliability of electric supply systems are classified, and a generalized approach to solution of such problems is proposed that is based on analyzing criterion functionals and constraints. Parameters considered include the vector of ways and means of improving reliability, the resultant vector of indices of actual or expected reliability at the terminals of the system, the vector of the degree of reliability of electric supply at an arbitrary terminal, the effectiveness of utilization of electric energy by a consumer at an arbitrary terminal and the adjusted inputs including those for ensuring reliability. Particular emphasis is given to use of the principle of duality in optimization problems. Fields of application are indicated for supply systems on different hierarchical levels. References: 13 Russian.
[24-6610]

PRINCIPLES OF REALIZATION OF AUTOMATED CONTROL OF WORKING CONDITIONS IN ELECTRIC NETWORKS

MARKUSHEVICH, N. S., Riga

[Abstract] The author describes the principles involved in setting up an automated dispatcher control system for the enterprises of electric networks. In this system the enterprise personnel collect and transmit primary data to a centralized computer, where the information is processed, and then make control decisions based on analysis of the processed data. The problem is considered not only from the engineering standpoint, but also with regard to the informational and psychological conditions of operation of the system. Difficulties resulting from the limited amount of primary information are overcome by using a thesaurus concept with respect to the data concentrated in the computing center of the power grid. The more highly developed such a thesaurus is, the less additional information will be required for immediate, short-term and long-range planning of the working conditions of the distribution network. The author discusses the experience of the Latvian Power Grid in using such a system for automated control of operation of its distribution networks. The results show that this kind of management can be economically effective. References: 12 Russian.
[24-6610]

ANALYSIS OF OPTIMUM PLANNING OF MUNICIPAL POWER SYSTEMS

GLAZUNOV, A. A., KUZNETSOVA, T. A., FEDOSEYEV, A. A., MRZEL, Ju. L., Ljubljana, Yugoslavia, and FLORIAN, R., Erfurt, East Germany

[Abstract] The paper gives data that emphasize the effectiveness of the systems approach in analyzing the problem of optimizing electric supply to the environs of large cities. This approach is exemplified by analysis of development of a power grid with hierarchical structure of subsystems with low, intermediate and high voltage. The proposed technique reveals the interdependence between major parameters of the subsystems. The results can be used to refine some of these parameters and enhance the reliability of optimization analysis. The mutual relations between sets of optimum parameters of municipal power grids show ways to optimize the strategy of development of major parameters, and can also be used to analyze the past course of development of these parameters. It is shown that with the current cost indices of cable lines and enclosed deep-entrance substations it makes sense to use 110-220 kV systems with increased power and short-circuit currents in medium-voltage distribution networks. Figures 4; references: 9 Russian.
[24-6610]

PRINCIPLES OF DESIGNING THE POWER SECTION OF HIGH-POWER THYRISTOR INSTALLATIONS

PODSHTEYN, L. S., KONOVALOV, G. S. and NEUYMIN, O. A., engineers, Uralenergotsvetnet Production Association

[Abstract] The paper discusses the design of the power section in thyristorized equipment for electrolysis in the nonferrous metals industry. The main component in such sections is a controlled power rectifier for 6.3 or 12.5 kA. A water-cooled module based on square copper stock measuring 60 x 60 mm in cross section with central opening 30 mm in diameter accommodates the thyristor complexes for forward and reverse currents of one branch of the rectifier bridge. The T-630 thyristors used in the power section can be symmetrically placed on the cooling module since they have about the same thermal resistance toward the anode and toward the cathode. A cooling module 2 m long accommodates 10 thyristors (on one side) for an irreversible controlled rectifier, or 20 thyristors (on opposite sides) for a reversible rectifier. A rapid-action cutout is connected in series with each thyristor to prevent internal shorting. Power sections for handling currents from 6.3 to 25 kA are produced in standardized modules measuring 2100 x 800 x 2500 mm and weighing no more than 1800

kg. The rectifiers in the power section may be connected in a bridge circuit or in parallel in a zero-point circuit, depending on the parameters of the thyristor equipment, the available transformer equipment, the required power reserve and the parameters of the water used for cooling the thyristors. A two-loop cooling system is recommended for voltages higher than 300 V. The thyristor power section also includes voltage surge protection, control devices and control panels. Figures 2; references 3: 2 Russian, 1 Western.

[22-6610]

TOPPING A 300 MW POWER PLANT WITH TYPE GTA-18 GAS TURBINE UNITS

KUZ'MIN, G. I., candidate of technical sciences, and KIRILLOVA, R. P., engineer, All-Union Heat Engineering Institute

[Abstract] A description of plans developed at the special design office of the All-Union Heat Engineering Institute for using two GTA-18 gas turbines as a topping to boost the peak power on existing 300 MW power plants based on K-300-240 turbines. The hot exhaust gases from the GTA-18 turbines are used to heat feed water in special high-pressure gas heaters. The proposed modification automatically increases the power of the steam-gas facility by approximately 62 MW. Changes are minimal. Savings will amount to about 4 million rubles in capital expenditures when the cost of an installed unit of power for a gas-mazut power plant is 110.8 rub./kW. The proposed topping can be used on 300 MW power plants with K-300-240 turbines and any type of steam boilers to get peak power with diesel fuel, and as a base unit with natural gas. Figures 2; references: 2 Russian.
[7-6610]

PRESENT AND FUTURE OF THE PENZA PRODUCTION ASSOCIATION FOR DIESELS AND TURBOCOM-
PRESSORS

POTANIN, V. A., engineer

[Abstract] A brief outline of the activity of the Penza Production Association for
Diesels and Turbocompressors and the future outlook for the enterprise. This is one
of the youngest associations in the engine building sector of industry, which pro-
duced its 10,000-th diesel in 1980. Specialization is in production of diesels and
diesel generators with power of 665-1470 kW for heavy switching locomotives and ma-
rine installations, as well as in making standardized turbocompressors for diesels
with power of 440-2950 kW, and oil and water pumps. Major series production in-
volves diesel generators with the 6ChN31.8/33 engine (type D50). The current five-
year plan will see an increase in production of the improved model of these diesel
generators based on the ChN26/26 engine. In production at the present time are 27
modifications of six sizes of turbocompressors, and a new series of sizes is being
developed. Work is also in progress on developing turbocompressors for supercharged
medium-speed ChN26/34 and ChN36/40 diesels. The association is now being expanded.
The first phase of reconstruction was started in 1977, including construction of a
new machine shop and assembly plant and a department for short-series turbocompressor
construction. The volume of expansion will be considerably increased during the
Eleventh Five-Year Plan. Plans have been made to use more tape-controlled and com-
puterized machine tools. Work is now being done on installing an automated enter-
prise management system. Labor organization is increasingly based on the brigade
form of production.
[19-6610]

SOME RESULTS OF INVESTIGATION OF DIESEL FUEL INJECTORS WITH ELECTROMAGNETIC CONTROL

BARSUKOV, S. I., doctor of technical sciences, professor, MURAV'YEV, V. P., candidate of technical sciences, docent, and BUKHVALOV, V. V., candidate of technical sciences, OPI [expansion not known]

[Abstract] An analysis is made of the operation of fuel injectors with electromagnetic control of the spray mechanism. It is shown that this type of control has a lower limit on the time of displacement of the needle valve from the closed to the open state and back that is imposed by the dependence of the starting force on the cross section of the armature in the case of magnetic saturation of the steel in the moving part of the magnetic circuit. Speed cannot increase after the mass of the armature equals or exceeds the mass of the other moving components and the needle valve. Apparently the limiting times of action are 0.5 ms for raising the needle, and 0.8 ms for lowering the needle. This limitation restricts the use of electromagnetic injectors to a narrow class of diesel engines. Therefore it is recommended that an electromechanical needle drive be used to increase the speed of action of controlled injectors. Figures 2; references: 4 Russian.
[21-6610]

ON THE POSSIBILITIES OF IMPROVING THE DIESEL

SMIRNOV, A. A., engineer, Institute of Mining imeni A. A. Skonchinskiy

[Abstract] A diesel engine design is proposed in which the principal motion is produced by a cam mechanism with a roller piston moving over a specially shaped surface to slide back and forth in straight cylinders of a rotating block. The pistons are hollow rollers that are self-sealed by deformation into an oval shape during the working stroke. It is expected that replacing the crankgear of the conventional diesel engine by the cam mechanism of the roller-piston diesel will greatly simplify design. Such an engine should also be more efficient, have lower heat stress, lower toxicity of exhaust gases, lower noise and vibration, be easier to start, and be more maneuverable. Figures 6; references: 6 Russian.
[21-6610]

CHOOSING RATIONAL PARAMETERS FOR REGULATING ALL-CONDITION SPEED CONTROLLERS OF MAIN MARINE ENGINES

CHEBLAKOV, Yu. P., engineer, BMP [expansion not known]

[Abstract] An analysis is made of data on operation of the UG-40TL speed regulator on the 5RD68 diesel marine engine on the Pioner Vyborga in heavy seas (8 points toward the bow of the vessel). Chart-recorded measurements included trim of the ship in degrees, shaft speeds of the main engine and turbocompressor in rpm, maximum pressure of the cycle in one cylinder in Pa, exhaust gas temperature in front of the turbine in °C, supercharging air pressure in the receiver in Pa and fuel pump rack position. Generalized parameters are proposed for rational selection of regulator settings. References: 4 Russian.
[20-6610]

RESONANT OSCILLATIONS OF A GYROSCOPE ON A RANDOMLY VIBRATING BASE

KUZ'MA, V. M., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] An investigation is made of the influence that random vibrations have on the stability of a heavy gyroscope and an astatic gyroscope, and conditions are determined for development of unsteady motions of the gyroscopes with various random perturbations. Resonant oscillations are defined as those for which coupling between the parameters of the external random perturbations and those of the system leads to oscillations with amplitudes an order of magnitude or more higher than those of "non-resonant" oscillations. A symmetric gyroscope is considered in a Cardan suspension with horizontal axis of rotation of the outer ring, the center of gravity being shifted relative to the stationary point of the gyroscope along the axis of free rotation of the rotor. The centers of inertia of the rings of the Cardan suspension coincide with the stationary point of the gyroscope. The mass of the base is much greater than that of the rings and rotor taken together. It is shown that in the case of random vibrations of gyroscopes resonant oscillations may occur that require greater energy and less dissipation of energy than resonant harmonic oscillations, although for certain values of parameters they may be comparable with respect to these indices. At the same time, where there are random vibrations of the base unsteady oscillations may arise over a wider range of mismatch between the carrier frequency of the perturbation and the corresponding combination of natural frequencies of the system as compared with resonant oscillations in the case of harmonic perturbations. Figures 3; references: 3 Russian.
[3-6610]

A STEADY-STATE PROTON BEAM INJECTOR WITH CURRENT OF 1 AMPERE AND ENERGY OF 100 keV
WITH ION SOURCE OF THE 'ION PUMP' TYPE

KOVAL'SKIY, G. A., KARETNIKOV, D. V., MEN'SHIKOV, M. I., PLESHIVTSEV, N. V. and
SHEMBEL', B. K.

[Abstract] The paper describes a cw ion beam injector for a high-current accelera-
tor with input acceptance of 10 cm·mrad. The injector was developed in 1967. In
this injector the "ion pump" source has a discharge chamber with gas pressure of
about 0.1 Pa. The arc is struck in an axial magnetic field of about 0.02-0.04 T.
The proton beam is close to laminar and contains about 70% protons at the injector
output. The proton content is increased to 95% by focusing coils and a collimator.
Beam intensity reaches 1.3 A at an energy of 100 keV. At this level of operation,
50% of the gas flow entering the source is converted to the ion beam. Tests of 8-10
hours of continuous operation over a three-week period showed the stability of opera-
tion and beam parameters. Development of this injector was a vital step in making
and testing the first high-current cw proton linac in the Soviet Union. Proton con-
tent at the current collector of the accelerator is more than 99% of the beam current.
Figures 5; references 7: 5 Russian, 2 Western.
[15-6610]

FILM PHOTOVOLTAIC CELLS BASED ON SOLID SOLUTIONS OF $Zn_xCd_{1-x}S$

AZIMOV, S. A., MIRSAGATOV, Sh. A., AKHMEDOV, R. and RASULOV, D. T., Physicotechnical
Institute imeni S. V. Starodubtsev, Uzbek SSR Academy of Sciences

[Abstract] The authors consider the feasibility of improving the efficiency of
pCu_2S-$nCdS$ heterojunction photovoltaic cells by replacing the CdS base material with
a compound that has better accord with the lattice constant of Cu_2S and closer energy
of electron affinity. A compound that meets these requirements is $Zn_xCd_{1-x}S$ with

x = 0.1-0.2. To get films of solid solution with required electrophysical properties, a technique is developed for growing $Zn_xCd_{1-x}S$ ($0 \leq x \leq 1$) on a molybdenum substrate based on a gas-transport method using hydrogen. Sources of CdS and ZnS are placed in different zones of the reactor with temperatures maintained at 900 and 1100°C. X-ray structural analysis shows that the resultant films are homogeneous and have the structure of wurtzite. The $pCu_{2-x}S-nZn_xCd_{1-x}S$ heterojunction was produced by immersing the film in a copper solution of $CuCl \cdot 2H_2O$ at 80°C. The specimens were held in the solution for 5-10 s then air-dried and formed under a 400 W lamp for an hour. It was found that the sensitivity of the cells shifts toward the short-wave region with increasing Zn content in the Zn_xCd_xS solid solution. Optimum composition is at x = 0.15-0.17 where the spectral band of photosensitivity extends from 250 nm to 950 nm with maximum at 490 nm. Such cells can convert light close to the ultraviolet to electrical energy with efficiency of about 8.7%. By minimizing losses, it should be possible to raise efficiency to 10%. Figures 2; references 3: 1 Russian, 2 Western.
[2-6610]

INVESTIGATION OF THE OPTICAL CHARACTERISTICS OF A UNIT REFLECTOR OF A SOLAR POWER FACILITY

REKANT, N. B., APARISI, R. R. and KOKHOVA, I. I., State Scientific Research Power Engineering Institute imeni G. M. Krzhizhanovskiy

[Abstract] The paper gives the results of studies of a unit reflector for a large solar power facility. The research was done to determine losses of radiant energy due to the absorption and reflection of mirrors, scattering of radiation in the atmosphere, and also to determine the dimensions of the image and the energy characteristics of the reflected flux. On the first stage of the tests, the reflector was made in the form of a parabolic surface, and the receiver was a flat or cylindrical calorimeter. Because of the complications involved in making and adjusting a curved reflector, it was decided to work with flat reflectors. The optical tests of reflectors were done in conjunction with development of a system for tracking the sun. A system was developed with accuracy of 3-7 angular minutes in tracking. Field tests of the optical properties of the reflector were done in Armenia with a 3 x 5 m reflector comprised of 28 flat mirrors measuring 750 x 720 x 6.7 mm. Zenith rotation was automatic, and azimuthal motion was by a manual drive. The receiver of the reflected radiation was a flat 5 x 9 m screen that could be rotated around a vertical tower. The total flux of reflected radiation in the plane of the screen was determined at distances of 50-373 m between reflector and receiver. The method of measurement is explained. Curves of equal density of radiation reflected from the

unit reflector are given for different distances. It was found that maximum angular deviation of the reflected rays is less than 30 angular minutes. The ratio of maximum reflected radiation at the screen to the average incident solar radiation on the reflector ranges from 1.18 at 50 m to 0.27 at 373 m. Figures 4; references 6: 4 Russian, 2 Western.
[2-6610]

INVESTIGATION OF THE STANDART-460M He-Ne LASER STABILIZED BY SATURATED ABSORPTION IN IODINE-127

KAPRALOV, V. P., KRYLOV, P. S., MIRONOV, A. V., PRIVALOV, V. Ye. and TKACHENKO, L. P.

[Abstract] The paper describes the Standart-460M He-Ne laser that differs from the prototype Standart-460 in the construction of the cavity and in certain peculiarities of the AFC circuit. The active element and absorbing cell are secured to invar carriages that can be slid along invar rods clamping the mirror holders, or can be immobilized in any position. The design ensures high passive stability: frequency drift when the AFC system is disconnected is 150 kHz/minute. Changes made in the AFC circuit included the d-c amplifier, the oscillator, and the amplifier of the third harmonic of the controlling signal (3f amplifier). The parameters of the main components of the AFC system are: d-c amplifier gain about $2 \cdot 10^4$ with a passband of 700 Hz; gain in the slow-action loop of d-c amplifier regulation ($\tau = 1000$ s) at least 10^4; gain of preamplification stages and 3f amplifier about 10^4 for a 3f amplifier passband of 160 Hz; signal-to-noise ratio at the output of the 3f amplifier 20-25. Studies were done on the stability and reproducibility of frequencies of the Standart-460M laser with stabilization with respect to different peaks of iodine-127 absorption. The signal spectrum was monitored by the S4-25 analyzer, and the frequency corresponding to the intervals of the saturated absorption peaks was measured by the F5035 frequency meter and recorded by a digital printer. Special shock mounting was used, and the lasers were kept under a transparent sound hood to prevent acoustic disturbances. Frequency instability was determined by statistical processing of beat signals, and was found to be about $(1-2) \cdot 10^{-11}$ averaged over a time of 10 s. Frequency reproducibility of laser emission was determined by the ICWM method with alternate stabilization on four peaks: d, e, f, g. Statistical processing of 1-2 series of measurements each day from July through November 1979 showed a difference between average frequencies of 14 kHz ($2.8 \cdot 10^{-11}$) at a standard deviation of 37 kHz ($7 \cdot 10^{-11}$). Figures 5; references 13: 7 Russian, 6 Western.
[18-6610]

16

METHODS OF REDUCING DIVERGENCE OF EMISSION FROM FLASH-PUMPED RHODAMINE-6G DYE LASERS

SMIRNOV, V. S.

[Abstract] An experimental study is done on some ways of reducing emission divergence in Rhodamine 6G dye lasers with flashlamp excitation. It is found that emission divergence for lasers of this type can be reduced by methods of selecting transverse modes of the cavity while minimizing thermo-optical distortions of the active medium. The best technique for doing this is to place a highly reflective rod made of a material that does not interact with the active medium of the laser along the axis of the dye cell over its entire length. Such a device suppresses transverse modes and at the same time improves uniformity of illumination of the working space of the cell. Such a system reduces divergence to 2-4 mrad without appreciable losses of lasing energy. The author thanks N. G. Bakhshiyev for interest in the work and useful discussion of the results. Figures 4; references 11: 10 Russian, 1 Western. [18-6610]

IMAGE FIELD OF A WEDGE SCANNER

SHEYNIS, N. V.

[Abstract] An analytical study is done on the action of a wedge scanner on a ray or beam of parallel rays arbitrarily oriented in object space. It is assumed that the scanner is comprised of simple components with angular velocities of equal absolute magnitude and opposite direction. The analysis is based on consideration of the image quality of an off-axis point of an infinitely remote object deflected by such a pair of wedge components mutually rotating about the axis that contains them. It is shown that off-axis image quality depends on the ratio of structural parameters of the scanner. Steps are recommended for minimizing aberrations over the entire image field of a wedge scanner. The effectiveness of these measures is dependent in large degree on proper choice of glass grades, especially in the case of compound elements of rotating wedge prisms. Figures 2; references 11: 9 Russian, 2 Western. [18-6610]

EFFECT THAT ACCURACY OF REGISTRATION HAS ON THE RESOLUTION OF A SPECTRAL INSTRUMENT

GORSKIY, S. M. and KOZHEVATOV, I. Ye.

[Abstract] An attempt is made to establish a general relation between spectral resolution and mean-square noise over intervals of resolution both wider and narrower than the instrument function of spectral equipment. The analysis is based on methods of solving inverse stability problems. It is found that such a general relation between resolution and the noise component in the spectrum depends on the form of instrument function of the equipment. The curves are plotted for the four most widely used instrument functions, with the number of resolved intervals on the width of the instrument function laid off along the vertical axis versus the parameter showing how many times detection accuracy must exceed the required accuracy of reconstruction to get the corresponding resolutions laid off along the horizontal axis. Analysis of the results shows that there are not restrictions in principle on "exchanging" detection accuracy for instrument resolution, although the "price" of ultraresolution is extremely high. Figures 2; references: 4 Russian.
[18-6610]

AN ECHELLE SPECTROGRAPH WITH COMPENSATED ASTIGMATISM

NAGULIN, Yu. S., PAVLYCHEVA, N. K. and YAKOVLEV, E. A.

[Abstract] A spectrograph for the 200-800 nm spectral range is proposed in which astigmatism of the collimator and chamber mirrors in an Ebert-Fusty arrangement is compensated by using an echelle grating with variable line spacing. The device has a relative aperture of 1:10. The grating has a blaze angle of 51°30', giving inverse linear dispersion of 0.16 nm/mm for 200 nm when the focal length of the chamber lens is 500 mm. Crossed dispersion is provided by a quartz prism in front of the grating. The beam dispersed in two directions is focused in the form of 90 lines on a television cathode with diameter of 40 mm. The aberration of the spectrograph does not exceed 0.03 mm in the meridional plane and 0.1 mm in the sagittal plane over the entire field. Figures 2; references 4: 3 Russian, 1 Western.
[18-6610]

ANALYTICAL METHOD OF CALCULATING SHIMS FOR CORRECTING THE FIELD OF ELECTROMAGNETS

BOL'SHAKOV, A. Ye. and GOL'DIN, L. L.

[Abstract] Shims on the edges of the polepieces can considerably improve the quality of the magnetic field of electromagnets without changing the weight or power consumption of the magnet system. The authors propose a method of calculating the tolerances for making and installing shims for a planar field. The proposed technique gives the correction realized by installing shims with usable accuracy of 10-15%. The result can be considerably improved if the field distribution with and without shims is measured at even one point. The procedure is worked out for the C-blocks of the proton synchrontron at the Institute of Theoretical and Experimental Physics, and can be modified to calculate other magnet systems. The authors thank V. I. Nikolayev for discussing the work. Figures 4; references: 3 Russian.
[17-6610]

BAR QUADRUPOLE LENSES WITH PERMANENT MAGNETS

SKACHKOV, V. S.

[Abstract] Permanent-magnet salient-pole quadrupole lenses give high-gradient fields with high linearity of the working field. However, the lenses described in the literature are awkward and require complicated equipment for controlling the gradient. In this paper the author proposes a consequent-pole bar quadrupole lens with permanent magnets that consists of a tubular nonmagnetic drum with sockets containing 12 $SmCo_5$ rods held in place by setscrews. The lens is 20 mm long with outside diameter of 34 mm. The rods are 6 mm in diameter. The lengthwise gradient measured on the axis by a harmonic coil is 2.6 kGs/cm. The proposed design has an insignificant scattered field, is smaller in diameter than an analogous salient-pole lens, requires no yoke, and the gradient can be controlled over a wide range. The author thanks I. M. Kapchinskiy for formulating the problem, assistance and continued interest in the work, S. V. Skachokov for constructive criticism on the early stages, and N. V. Lazarev for useful advice, and also Ye. N. Zubkov, who was of considerable assistance in making the lens. Figures 4; references: 3 Russian.
[17-6610]

A CRYOGENIC LARGE-APERTURE HYDROGEN-HELIUM TARGET

GOLOVANOV, L. B., MAZARSKIY, V. L. and TSVINEV, A. P., Joint Institute of Nuclear Research, Dubna

[Abstract] The paper describes a target developed at the Joint Institute of Nuclear Research for nuclear and hypernuclear experiments in the high-energy laboratory. The device has three inner vessels in a vacuum jacket. One vessel is filled with liquid H_2, another is filled with liquid He, and the third is left empty for background measurements. The jacket has large apertures that minimize the amount of wall material on the path of particles leaving the target in the front and back over angle ranges of $0 \pm 150°$ in the horizontal plane and $0 \pm 48°$ in the vertical plane for vertices at the centers of the vessels. The jacket is made of a rigid frame over which a mylar shell is stretched. The shell is joined to the top and bottom of the frame by cementing and wrapping with nylon thread. The vessels are cylindrical with axis perpendicular to the particle beam, and have a working length (diameter) of 100 mm. The authors thank Yu. T. Borzunov, A. I. Kalmykov, M. V. Levin, V. F. Chumakov and colleagues of the Cryogenics Department for helping to make and test the target. Figures 2; references: 4 Russian.
[17-6610]

ELECTRONIC MODULE OF A LASER FREQUENCY STABILIZATION SYSTEM

GOL'DORT, V. G. and OM, A. E., Institute of Thermal Physics, Siberian Department, USSR Academy of Sciences, Novosibirsk

[Abstract] The paper describes the electronic part of a laser frequency stabilization system that keeps the lasing linewidth of a methane-cell He-Ne laser to about 7 Hz, and maintains instability of the average frequency to within 1 Hz, this instability being determined by factors that are independent of the electronic system. Response of the system is nearly instantaneous, and frequency can be maintained indefinitely (under laboratory conditions). The system is essentially an optimalizing controller that sets the frequency to the center of resonance in the laser emission power. A test signal modulates the laser frequency, causing power modulation in such a way that the signal of the first harmonic is proportional to the first derivative of the laser emission characteristic, and consequently zeroing this signal sets

the frequency to the extremum of the characteristic. The modulated frequency of the laser goes to a photocell and is preamplified by a factor of 100, after which it is sent to the electronic module. This module contains two static control units that compensate for thermal and vibrational-acoustical perturbations. The transfer ratio in the "slow" channel of thermal perturbations is 10^{10}, and the ratio in the "fast" channel is $5 \cdot 10^7$. The gradient of the amplitude-frequency response is 3s dB/-decade. It should be possible to reduce lasing linewidth to 1 Hz by using low-noise photocells. Figures 3; references 4: 2 Russian, 2 Western.
[17-6610]

FLUID MECHANICS

STONELEY WAVE AT THE BOUNDARY BETWEEN A FLUID AND A PRESTRESSED BODY

ZHUK, A. P., Institute of Mechanics, UkSSR Academy of Sciences

[Abstract] The problem is propagation of a Stoneley wave with a small amplitude along the plane boundary between an ideally compressible fluid and a prestressed compressible elastic body. This problem is analyzed in a Lagrangian system of coordinates (x_1, x_2, x_3) which in the natural state becomes a Cartesian system. The coordinate plane $x_2 = 0$ coincides with the plane of the boundary and the fluid fills the $x_2 < 0$ half-space. The analysis is based on the linearized theory of waves with large finite initial strains and the equations of motion are solved for the case of a uniform initial state. The solution is applied to a specific example, namely a harmonic potential. The article was submitted by academician (UkSSR Academy of Sciences) A. N. GUZ'. Figures 1; references 7: 6 Russian, 1 Western.
[142-2415]

PRINCIPLES OF CONSTRUCTING A GENERALIZED THEORY OF COMBUSTION IN DIESELS

SVIRIDOV, Yu. B., doctor of technical sciences, TsNITA [expansion not known]

[Abstract] The conclusion of an article started in "Dvigatelestroyeniye," No 9, 1980 pp 21-23. An analysis is made of the current state of development of the theory of the combustion process in diesel engines. It is shown that processes of mixture formation play a decisive part in combustion. Basic principles are worked out for constructing a method of calculating the combustion process in diesels. Experimental data are given that confirm the zone model of the burning fuel jet, which maintains that processes of heat and mass exchange occur only in the frontal zone where the particles encounter fresh charge, are heated, vaporized and retarded. On their

way to the zone the particles move in orderly fashion without slowing down and with nearly no heating due to gradual entrainment of the medium by the leading particles. In the mantle of the burning fuel jet, the particles interact weakly, and come into strong thermal interaction with the medium immediately after leaving the nozzle. Experiments have shown that the average velocity of the entrained gas is about half the velocity of the fuel particles in the jet, so that with consideration of the micro-profile of particle velocities it can be assumed that the difference between the velocities of particles and gas on the path is small, and heat exchange is insignificant. It can be assumed that the particles interact in the jet region by collisions and coagulation at low temperatures, and by microexplosions and atomization at higher temperatures. Basic principles are given for calculating the velocities, heat exchange and mass exchange of fuel particles. Figures 8; references 15: 13 Russian, 2 Western.
[20-6610]

UDC 537.291.001

EXPERIMENTAL STUDY OF ELECTRIC WIND IN THE PRESENCE OF AN EXTERNAL FLOW

VERESHCHAGIN, I. P. and GONIK, A. Ye., Moscow

[Abstract] The authors consider experimental methods of determining the parameters electric wind. One of the best techniques now available for this purpose is analysis of the velocity field of fine particles (of the order of 1 µm) in the interelectrode gap by using an optical Doppler velocity meter. However, the error of such an analysis may exceed 5% unless special precautions are taken to eliminate the effects of external flows. It is shown that these effects depend on the position of the electrodes with corona relative to the direction of the flow, and also on the applied voltage. The flow has a maximum influence on electric wind when the direction of the flow is perpendicular to the electric field and to the corona electrodes, and the effect is minimum when flow perpendicular to the electric field is parallel to the electrodes with corona. The average velocity of the electric wind decreases over the entire interelectrode gap with increasing external flow. The degree of the decrease depends on the time that the moving volume of air remains in the field of the corona discharge, and also on the overvoltage causing ionization. The average wind velocity does not change for times greater than 1 s and overvoltages at least four times the threshold value. An external flow increases the standard deviation of wind velocity, which is an indication of increasing flow turbulence. As a result there is an increase in the difference between the average and maximum speeds of the electric wind. An improved procedure is given for using an optical Doppler velocity meter for measurements in strongly turbulized flow, and data are given on the average velocity of an electric wind with external flow in gaps of different configurations. Figures 4; references: 4 Russian.
[24-6610]

SELF-OSCILLATORY MOTION OF PARTICLES IN A HOMOGENEOUS ELECTRIC FIELD

BOLOGA, M. K., PUSHKOV, V. V. and BERKOV, A. B., Kishinev

[Abstract] An examination is made of the problem of intensifying heat exchange in coolants based on two-phase flows of gas and fine solid particles. One way to do this is by the action of an electric field. Since electroconvective heat exchange is determined by the intensity of motion of the dispersed material, the authors analyze self-oscillatory motion of electrically conductive particles in a horizontal flat capacitor with consideration of the force of gravity, aerodynamic drag and the elasticity of impact, assuming that the particles are spherical. Expressions are derived for the period of self-oscillations and instantaneous velocity. It is shown that when forces of adhesion are negligible, there is an optimum range of particle diameters for maximum heat exchange. As the degree of dispersity of the solid phase increases, the factor that increases the period of self-oscillatory motion is the aerodynamic drag. As dispersity decreases, the controlling factors become the force of gravity, inertia, and the elasticity of collisions with the electrode. Concentration curves are given for two fractions of dispersed material as a function of a parameter that describes the ratio of electrical and gravitational forces. Figures 3; references 19: 17 Russian, 2 Western.
[24-6610]

CALCULATION OF PLANAR TURBULENT BUOYANT JETS DISCHARGED VERTICALLY

BRUYATSKIY, Ye. V., Institute of Hydromechanics, UkSSR Academy of Sciences, Kiev

[Abstract] An integral method is proposed for solving the problem of the initial and main section of a plane turbulent buoyant jet. It is assumed that the jet is discharged vertically from a flat nozzle of given width at given velocity with known initial temperature. In the mixing layer, the density difference between the jet and the ambient atmosphere produces an Archimedes force resulting in movement depending on the density ratio either adding to the initial momentum or opposed to it. It is assumed that the fluid is incompressible and that the ambient medium is homogeneous, stationary and at a constant temperature lower than that of the jet. The proposed method of calculating the physical parameters of the jet involves a single free parameter of entrainment that is experimentally determined. Figures 5; references 8: 4 Russian, 4 Western.
[3-6610]

PROBLEMS OF HYDROELASTICITY FOR A VISCOUS COMPRESSIBLE LIQUID IN SPHERICAL COORDI-
NATES

GUZ', A. N., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] Problems of hydroelasticity are considered for interaction between elas-
tic bodies and a compressible viscous liquid. Three-dimensional equations of the
dynamic theory of elasticity are used to describe motion of the elastic body, while
linearized Navier-Stokes equations are used to describe small perturbations of the
quiescent viscous compressible liquid. The solutions are given in spherical coordi-
nates in terms of the solutions of three second-order scalar equations. The result-
ant representations of the solution are general for various steady-state and unsteady
problems of interaction between elastic bodies and compressible viscous liquids with
spherical interfaces. References 6: 5 Russian, 1 Western.
[4-6610]

A METHOD OF CALCULATING THE AXIAL FORCE THAT ACTS ON A TURBINE DISK WITH CONSIDERA-
TION OF LEAKAGE

BAYBIKOV, A. S., doctor of technical sciences, LISICHKIN, G. M., engineer

[Abstract] One of the main problems in designing powerful turbines is precise de-
termination of the axial force acting on the runner. Discrepancies between experi-
mental results and theoretical calculations are mainly due to failure to account for
radial pressure variation due to the interaction between minor flows and centrifugal
forces in the cavity between the rotating disk and the housing. The problem of
fluid flow between the disk and housing in turbines is complicated by the backflow
that results from injection of cooling gas or leakage through the diaphragm seal.
In this paper a method is proposed for calculating fluid flow between a turbine
housing and a disk without relief openings that has a seal on the outside diameter,
using general equations of motion of a turbulent stream. The results agree satis-
factorily with experimental data. Figures 5; references 10: 7 Russian, 3 Western.
[7-6610]

EXTREMUM BEHAVIOR OF THE SPEED OF ULTRASOUND AND OF SOME OTHER QUANTITIES IN THE
SUPERCRITICAL REGION OF WATER

YEROKHIN, N. F., engineer, and KAL'YANOV, B. I., candidate of physical and mathematical sciences, deceased, Taganrog Pedagogical Institute

[Abstract] The paper gives the results of systematic measurements of the speed of ultrasound in water for eight supercritical isotherms: t = 375.09, 377.08, 380.08, 390.08, 400.08, 425.78, 450.10 and 500.08°C. A comparison is made of the lines of supercritical extrema and the results of calculation of the adiabatic compressibility and the adiabatic exponent. The speed of ultrasound was measured as a function of pressure and frequency by an interferometric method with two lithium niobate piezoelectric transducers. Temperature was measured by a PTS-10 platinum laboratory resistance thermometer with accuracy to 0.01°C in the IPTS-68 scale, and pressure was measured by an MP-600 piston manometer class 0.05 through a mercury separator with optical display. Temperature was held within ± 0.01°C during measurement. The error of measurement of the speed of ultrasound was 0.03-0.1% for the frequency range of 0.48-10.38 MHz. The water specimen was doubly distilled and passed through ion-exchange resins and had conductivity of no more than $1.5 \cdot 10^{-5}$ $[\Omega \cdot m]^{-1}$ at 20°C. No decomposition products were observed during measurements in the supercritical region of water. A table is given summarizing the results of measurements of the speed of ultrasound in water for supercritical isotherms as a function of pressure for a frequency of 0.48 MHz. The speed of ultrasound passes through a minimum on all the isotherms. The sharpness of the minimum increases as the vicinity of the critical point is approached. Agreement with theoretical calculations for the 500.08°C isotherm is within 0.1% for pressures outside the vicinity of the minimum, where the discrepancy increases to 0.48%. Curves are given showing the isotherms of adiabatic compressibility and the adiabatic exponent. The curve for the minima of the speed of ultrasound is compared with the lines of maxima of the isobaric and isochoric heat capacities. These curves coincide only close to the critical point. The discrepancy between the lines of extrema in the supercritical region of water shows that there is no common line with properties like those of the liquid-vapor equilibrium curve. The measured values of the coefficient of absorption of ultrasound in the supercritical region of water pass through maxima. The results of this research can be used to study processes that take place in steam boilers and turbines on supercritical parameters. Figures 4; references 15: 14 Russian, 1 Western.
[6-6610]

MECHANICS OF SOLIDS

INTERACTION OF A BOUNDED SOUND BEAM AND AN ELASTIC HOLLOW SPHERE IN AN ACOUSTIC FLUID

PODUBNYAK, A. P. and POROKHOVSKIY, V. V., Institute of Application Problems in Mechanics and Mathematics, UkSSR Academy of Sciences

[Abstract] An analysis is made of echo signals produced by a pulse of a narrow sound beam upon incidence on a hollow spherical shell filled with an acoustic fluid. The source of sound is a membrane with an ideal radiation pattern which remains constant during the sounding process. The analysis is based on a simultaneous solution of the wave equations for an elastic body and two acoustic media, one inside and one outside the shell, for boundary conditions of hydroelastic contact and in accordance with the causality principle. Numerical solutions have been obtained for steel cups with a central angle of 30, 45, and 60° respectively, containing water. The amplitude of steady and transient elastic oscillations in the echo signal is found to increase as the incident sound beam is made narrower and the shell is made thinner. The first echo signal contains most of the energy of the acoustic field scattered in the direction of the source. As the incident sound beam is made wider, the amplitude of the first echo signal decreases and that of secondary echo signals increases so that the reflection pattern becomes more complex. The results of this analysis indicate the feasibility of optimally controlling the echo signal by adjusting the width of the incident sound beam relative to the sweep angle of the radiation pattern as well as the pulse duration and repetition rate. The article was submitted by academician (UkSSR Academy of Sciences) Ya. S. PODSTRIGACH. Figures 3; references 10: 5 Russian, 5 Western.
[142-2415]

INVESTIGATION OF THE VIBRATIONAL ACTIVITY OF ELASTIC COUPLINGS, AND A METHOD OF
REDUCING IT

RUMYANTSEV, O. A., candidate of technical sciences, docent, and SKURIDIN, A. A.,
candidate of technical sciences, Northwest Polytechnical Correspondence Institute,
Central Scientific Research Diesel Institute

[Abstract] Elastic couplings are widely used to compensate for shaft misalignment.
An analysis is made of the effect that design peculiarities and operation of such
couplings have on machine vibration. It is shown that misalignment of half-couplings
is a major source of vibrational activity of such couplings. The compensating action
of elastic couplings should be evaluated both from the standpoint of clutch design
and from the standpoint of operation of the unit when it is used to couple individual
machines. The main factor that increases coupling vibration is inaccuracies in manu-
facture of components. A method of dynamic centering is proposed for eliminating
vibration of elastic couplings. After prebalancing of the half-couplings, the coup-
ling is assembled and installed on a test stand, loaded by the rated torque at the
rated speed. The magnitude and phase of the coupling misalignment is then determined
from the oscillation of the shaft bearings and weights are placed on each half-coup-
ling with identifical static moments in antiphase to the measured misalignment. Fig-
ure 1; references: 5 Russian.
[19-6610]

PRELIMINARY CHECK ON TORSIONAL VIBRATIONS OF MARINE DIESEL-GEARBOX UNITS

SHILIKHIN, A. A., Dal'dizel' Plant

[Abstract] An analysis is made of vibrations that arise in the system that includes
the engine, gearbox and screw propeller on diesel-driven ships. Recommendations are
made on preventing dangerous resonances from arising in this type of aggregate vibra-
tion. It is necessary to take account of the influence that the screw shafting has
on aggregate torsional oscillations when designing the diesel-gearbox unit, and as a
rule there are no available data on specific power plants. A method is proposed for
preverifying such units with respect to torsional vibrations that gives a reliable
indication of how satisfactory a given diesel-gearbox design may be from the stand-
point of vibrational safety. Figures 5; references: 4 Russian.
[21-6610]

ADDITIONAL PERTURBATIONS ON ENGINE MASSES CAUSED BY A CHANGE IN THE MOMENT OF INERTIA
OF THE CRANKGEAR

ISTOMIN, P. A., doctor of technical sciences, professor, and SOROCHKIN, M. M.,
Leningrad Shipbuilding Institute, Zvezda Production Association

[Abstract]   Poincare's method is applied to solution of equations that describe the
torsional vibrations in the shafting of an engine with consideration of variability
of the moment of inertia of the crankgear. Criteria are derived for evaluating the
degree of influence that additional perturbations due to variability of the moment
of inertia of the crankgear have on stress amplitudes in different sections of the
system. It is shown that the effect is determined by the order and phases of the
additional perturbations. An example is given of calculation of the change in per-
turbing moments due to external forces and additional perturbing moments in the
5DKRN62/140 engine of the power plant on the Nikolay Zhukov diesel-driven ship as a
function of speed of rotation with consideration of the first three harmonics of
the moment of inertia of the crankgear. Figures 2; references: 4 Russian.
[21-6610]

INFLUENCE OF FORCED FLEXURAL OSCILLATIONS OF CRANKSHAFTS ON DIESEL VIBRATION

YANCHELENKO, V. A., candidate of technical sciences

[Abstract] A relation is found between flexural oscillations of a crankshaft and
the overall vibration of a diesel engine, and the fraction of the vibrational power
generated by crankshaft oscillations. An analysis is made of the influence that
flexural oscillations of crankshafts have on vibration of the U-25 diesel generator
with 6Ch15/18 engine, and on vibration of 6ChN21/21, 12ChN15/18 and 6Ch12/14 diesels.
It is found that for diesels of average size with speed of 1500 rpm or more, forced
flexural oscillations of the crankshaft in a range of 100-300 Hz constitute a major
cause of increased engine vibrations. A method based on energy characteristics is
proposed for evaluating the influence that forced flexural oscillations of crank-
shafts have on vibration in such diesels. An engineering formula is given for cal-
culating displacements of the webs. It is shown that diesel vibration due to this
source can be controlled by modifying the normal force acting on the webs of the
crankshaft, and by increasing the bending rigidity of the crank. Figures 5; refer-
ences: 9 Russian.
[20-6610]

ON SOLVING THE PROBLEM OF OSCILLATION OF NONLINEAR VISCOELASTIC RODS WITH CONSIDERA-
TION OF LONGITUDINAL FORCES

SHIRINKULOV, T. and TILAVOLDIYEV, Kh., Fergan Polytechnical Institute

[Abstract] The authors consider flexural vibrations of a straight viscoelastic rod
with absolutely rigid support at one end, while the support at the other end has vis-
coelastic pliancy with a given stiffness factor and carries a given point mass. It
is assumed that the physical properties of the material can be described by Boltzmann-
Volterra integral relations. The problem is reduced to solution of an integrodiffer-
ential equation of Volterra type for forced flexural oscillations of a nonlinear rod
with given initial and boundary conditions. The Bubnov-Galerkin procedure is com-
bined with a power-series method to reduce the solution to recursion formulas for
determining the unknown coefficients of the time series for displacements, veloci-
ties and accelerations of the rod with consideration of longitudinal forces. Refer-
ences: 11 Russian.
[1-6610]

APPROXIMATE EQUATIONS OF UNSTEADY OSCILLATIONS OF A THICK-WALLED CIRCULAR CYLINDRI-
CAL VISCOELASTIC SHELL

FILIPPOV, I. G. and KUDAYNAZAROV, K., Samarkand State Architectural Construction
Institute

[Abstract] Approximate equations are derived for oscillations of a thick-walled cir-
cular cylindrical shell as a degenerate system, i.e., engineering equations for the
torsional, longitudinal-radial and transverse oscillations of such a shell for both
symmetric and asymmetric behavior relative to the axis of symmetry. It is assumed
that the shell as a viscoelastic system conforms strictly to the mathematical theory
of viscoelasticity, and in the exact formulation is described by three-dimensional
equations of the linear theory of viscoelasticity. The derivation is based on ex-
pansion of unknown quantities in the initial integrodifferential equations of motion
and boundary conditions in series with respect to the degenerate radial coordinates.
In limiting cases the resultant equations yield the corresponding expressions for a
circular rod or a thin cylindrical shell. References: 2 Russian.
[1-6610]

ACTION OF PULSATING SHEAR STRESS ON SURFACES OF AN ELASTIC HALF-SPACE AND A LAYER

USMANALIYEV, A., Institute of Seismology, Uzbek SSR Academy of Sciences

[Abstract] The author considers the problem of a pulsating shear stress $\sigma_{y,z}$ moving over surface $y = 0$ of an elastic half-plane or an elastic layer $0 \leqslant y \leqslant h$ at a given velocity D. The wave field in the medium then depends on displacement W perpendicular to plane (x,y) and satisfies the wave equation

$$\frac{\partial^2 W}{\partial x^2} + \frac{\partial^2 W}{\partial y^2} = \frac{\partial^2 W}{\partial t^2} \frac{1}{b^2},$$

the boundary conditions

$$\sigma_{yz} = f(x - Dt) \exp(i\omega t) \text{ at } y = 0$$

and (in the case of an elastic layer) the condition

$$\sigma_{yz} = 0 \text{ or } W = 0 \text{ at } y = h.$$

An exact solution of the problem is found by the method of operational calculus. The solution takes the form

$$W(x,y,t) = W_0(x,y,t) \exp(i\omega t),$$

where the auxiliary function W_0 is found by introducing moving coordinates. A graph is given showing the relation between the real part of the auxiliary function and the frequency of pulsations for different velocities. Figure 1; references: 3 Russian.
[1-6610]

INFLUENCE OF AN ELASTICALLY STRAINED RING ON STRESS DISTRIBUTION IN A SPHERICAL SHELL WITH A CIRCULAR OPENING

PELEKH, B. L., GALASI, A. A. and GLEBA, A. Yu., Institute of Applied Problems of Mechanics and Mathematics, UkSSR Academy of Sciences, L'vov, and Uzhgorod State University

[Abstract] An examination is made of the feasibility of reinforcing circular openings in a spherical shell by using an elastically strained ring to produce a pre-stressed state to absorb part of the stresses in external loading. The problem of optimizing the parameters of the prestraining to increase structural strength is formulated, and the method of solution is explained. A thin isotropic spherical shell is considered that is weakened by a small circular hole of given radius and subjected to an arbitrary axisymmetric load. The edge of the hole is reinforced by an elastically deformed ring of constant cross section. Two extremum problems are considered relating to the influence that the parameters of predeformation of the ring have on the stressed state of the shell: A. for given geometric and elastic characteristics of the shell to find parameters of predeformation that minimize the maximum stress in the shell; B. to find the optimum predeformation parameters that minimize the maximum stress in the shell with the condition

$$\max\sigma_{ex}^{r} \leq n_{r}\max\sigma_{ex},$$

where $n_{r} = [\sigma]_{r}/[\sigma]$; σ_{ex}^{r}, $[\sigma]_{r}$ are the calculated and permissible stress in the ring respectively; σ_{ex}, $[\sigma]$ are the same stresses in the shell. Solution of problem A for any stiffness enables selection of an elastically strained ring that completely eliminates stress concentration near the opening, so that the strength of the reinforcing ring determines the strength of the entire structure. Solution of problem B shows that it is most effective to use a prestrained ring when parameter n_{r} is much greater than unity. Figures 3; references 7: 6 Russian, 1 Western.
[3-6610]

OSCILLATIONS OF LONGITUDINAL COMPRESSED CYLINDRICAL AND SLIGHTLY TAPERED SHELLS

PAL'CHEVSKIY, A. S., PRYADKO, A. A., KAPLYA, P. G., GALAKA, P. I. and NOSACHENKO, A. M., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] The authors consider the influence of reinforcements and axial loading on oscillations of shells with openings. It is assumed that a cylindrical shell of predetermined dimensions is weakened by regularly spaced large rectangular openings with edges reinforced by stringers and closed bulkheads. The surface of the shell is reinforced by uniformly spaced less rigid stringers and bulkheads. The shell is freely supported, and an axial force is applied to the end as longitudinal stresses of given magnitude uniformly distributed over the end face. The problem is solved by a mixed energy method, assuming smallness of displacements and a zero-moment stressed and strained state. It is shown that the theoretical results for closed ribbed cylindrical shells are applicable to slightly tapered shells. Figures 3; references 8: 6 Russian, 2 Western.
[3-6610]

SOME SOLUTIONS FOR TOROIDAL SHELL PROBLEMS

SEL'SKIY, Yu. S., Central Scientific Research Institute of Design and Planning in the Structural Steel Industry and Bridges, Dnepropetrovsk

[Abstract] The author considers solutions of homogeneous differential equations of a toroidal shell for the case where condition $\omega \gg 1$ is not satisfied. Here $\omega = r\alpha/c$ $\alpha = r/R$, $c = h/2\sqrt{3(1 - \mu^2)}$. Such cases are possible only when $\alpha \ll 1$. The homogeneous differential resolving equations for the symmetric ($k = 0$) and antisymmetric ($k = 1$) problems are reduced to a Mathieu equation which is solved by asymptotic methods and numerical integration. The solution in Mathieu functions enables evaluation of damping of the solutions with respect to parameter ω, and distinguishes cases of separate satisfaction of boundary conditions on each of the edges. A three-term special solution of the problem in Lommel functions is found by asymptotic methods at larger α. Figures 3; references 5: 4 Russian, 1 Western.
[3-6610]

DETERMINATION OF CRITICAL PARAMETERS OF A LOAD THAT FALLS OFF RAPIDLY IN TIME (DELTA PULSE)

AMIRO, I. Ya., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] Within the framework of the linear problem as applied to the calculation of rods, plates and shells, the author formulates an analytical criterion of dynamic loss of stability that is suitable for determining the critical parameters of a load that decreases rapidly in time and has an initial amplitude that exceeds the Euler critical value. The problem is formulated as follows. Let compressive stresses that act in a rod, plate of cylindrical shell as a result of external loading be uniformly distributed and change in time by the law $N = N_0 - \gamma t$, where $0 \leq t \leq N_0/\gamma$. It is required to determine the combination of maximum stress N_0 and time rate of change γ such that intensive development of flexures is possible. The proposed criterion of dynamic stability is used to determine the "critical" combination of the ratio of initial compressive stress to the Euler value and the dimensionless rate of decline in loading for a rod, a rectangular plate and a cylindrical shell. Figures 3; references: 5 Russian.
[3-6610]

ON THE PROBLEM OF STABILITY OF A CYLINDRICAL SHELL WITH TWISTING

TOVSTIK, P. Ye., Leningrad State University

[Abstract] Stability of a thin circular cylindrical shell of intermediate length is determined with twisting by torques applied to its ends. Boundary conditions with both rigid and hinged fastening are considered and an investigation is made of the influence that boundary conditions have on the upper critical load and the form of loss of stability. It is found that the solution given by Vol'mer [see A. S. Vol'mer, "Ustoychivost' deformiruyemykh sistem" (Stability of Deformable Systems), Moscow Nauka, 1967] is a good approximation for both versions of boundary conditions. Reference: 1 Russian.
[3-6610]

WAVE PROPAGATION IN A CYLINDRICAL SHELL WITH A VISCOUS COMPRESSIBLE LIQUID

GUZ', A. N., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] The author considers the general (non-axisymmetric) problem of wave propagation in an isotropic shell filled with a viscous compressible liquid. The analysis is based on general solutions of linearized Navier-Stokes equations for a quiescent viscous incompressible liquid [A. N. Guz', "On Problems of Aerohydroelasticity for Bodies with Initial Stresses" PRIKLADNAYA MEKHANIKA, Vol 16, No 3, 1980, pp 3-21]. The equations of motion of the shell are derived by using the Kirchhoff-Love hypothesis. The resultant dispersion equations include simpler models of liquids as limiting cases, specifically an incompressible viscous liquid and an ideal liquid. References 6: 5 Russian, 1 Western.
[5-6610]

ON A METHOD OF CONSTRUCTING EQUATIONS OF THE SHEAR THEORY OF THERMOELASTICITY OF LAMINAR PLATES AND SHELLS

KHOROSHUN, L. P., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] The disadvantages inherent in the method of hypotheses for deriving equations of the theory of laminar plates and shells can be circumvented by replacing the kinematic hypotheses with the concept of a homogeneous stress-strain state of a thin-walled element of a laminar structure. Two modifications of this technique have developed: one that disregards transverse tangential stresses, leading to equations that coincide with Kirchhoff-Love theory, and the other that considers such stresses, leading to equations of greater generality than the Timoshenko theory. In this paper the author uses such an approach to get equations of thermoelasticity of laminar plates and shells with consideration of transverse tangential stresses. The initial equations are constructed for a plate of given thickness comprised of an arbitrary number of orthotropic layers. The final equations of thermoelasticity are applied to analysis of the problem of bending of a cantilever beam, and it is shown that the results agree completely with the exact solution of the corresponding equations of the plane problem of thermoelasticity with exact boundary conditions on the lateral faces and integral conditions on the ends. Figure 1; references: 6 Russian.
[5-6610]

THE METHOD OF BOUNDARY PARAMETERS AND ITS APPLICAT ON TO SOLUTION OF PROBLEMS OF
STABILITY OF CYLINDRICAL SHELLS WITH DIFFERENT BOUNDARY CONDITIONS

MALYUTIN, I. S., Moscow

[Abstract] A general solution is found for an arbitrary differential equation with
constant coefficients and even derivatives in a form that contains as arbitrary
quantities the values of even (odd) derivatives at boundary points, or the values
of even derivatives at one point and of odd derivatives at another, i.e., the values
of certain boundary parameters. The technique of solving boundary value problems by
using a general solution in this form to reduce the number of arbitrary quantities
to be determined from the boundary conditions and to get an explicit solution is
called the method of boundary parameters. The author shows how the proposed method
is used to solve equations of stability of cylindrical shells, and derives character-
istic equations in explicit form for a number of boundary conditions. Numerical re-
sults are given. References 3: 2 Russian, 1 Western.
[5-6610]

ELASTIC-PLASTIC BENDING OF SHALLOW CYLINDRICAL SHELLS

KOLESNIK, I. A. and TROSHIN, V. G., Dnepropetrovsk Metallurgical Institute

[Abstract] Elastic-plastic equilibrium of a shallow cylindrical shell is analyzed
within the framework of strain theory, using a method of variable stiffness parame-
ters. The shell material is taken as incompressible in both the elastic and plastic
stages of deformation. It is assumed that the generalized stress-strain curve can
behave in any manner. The proposed algorithm is applied to solution of the problem
of elastic-plastic equilibrium of a closed cylindrical shell under the action of two
self-balanced concentrated forces. Figures 3; references 4: 3 Russian, 1 Polish.
[5-6610]

EXPERIMENTAL STUDY OF THE STABILITY OF CYLINDRICAL SHELLS WITH ELASTIC FRAMING RIBS

ANTONENKO, E. V., ZOGOL', V. N., MIKHAYLOV, V. V. and SHIRSHLIN, V. P., Saratov
Higher Military Command Academy

[Abstract] Tests were done to determine the influence that the bending stiffness
of framing ribs and boundary conditions have on the critical pressure of cylindrical
shells. The edges of cardboard, celluloid or steel cylinders were secured to flat
endpieces made of aluminum alloy. Elastic framing ribs were placed between the end-
pieces with equal spacing from the endpieces and from each other. The ribs were
made by winding a band of the shell material around the cylinder in different numbers
of layers to vary the stiffness. Each layer was cemented to the structure. Hydro-
static stress was produced by evacuation. The critical pressure was determined from
a manometer reading at the instant of buckling. It was found that ribs with rela-
tive moment of inertia of 0.3 or more can be considered absolutely rigid (three- or
four-layer ribs). A single section between ribs freely supported on the ribs can be
taken as the computational model of a shell with several ribs. The experimental re-
sults agree satisfactorily with theoretical data for the critical pressure with con-
sideration of "smearing" of the stiffness of one or two framing ribs upon overall
loss of stability of the shell and ribs. Figures 2; tables 3; references: 4 Russian.
[5-6610]

DISPLACEMENTS AND NORMAL STRESSES WITH CONSIDERATION OF SHEARING OF SHORT OPEN THIN-
WALLED CYLINDRICAL SHELLS AND RODS

KHOLOPTSEV, V. V., Odessa Institute of Marine Engineers

[Abstract] The paper is related to research by A. L. Gol'denveyzer [see "Prikladnaya
matematika i mekhanika" Vol 13, No 6, 1949, pp 561-596] and V. B. Meshcheryakov
["Trudy Moskovskogo instituta inzhenerov zhelezno-dorozhnogo transporta. Voprosy
prikladnoy mekhaniki" 1968, No 260, pp 82-93], and continues the work of L. N.
Vorob'yev ["Trudy Novocherkasskogo politekhnicheskogo instituta" Vol 136, 1963, pp
3-9] and P. D. Mishchenko ["Trudy Novocherkasskogo politechnicheskogo instituta"
Vol 42/56, 1958, pp 54-85; "Trudy Altayskogo politekhnicheskogo instituta" No 3,
1967, pp 32-41]. The same assumptions are made in calculating displacements and
stresses in the general case of loading with development of the four simple strains

accompanied by shearing. An expression for normal displacements is proposed that accounts for the experimentally observed fact that the zero points of displacements due to shearing do not always coincide with the zero points of displacements due to bending. This relation can be used in an iteration process to refine the equations derived by other authors for generalized displacements. Figures 2; references: 6 Russian.
[5-6610]

STABILITY OF ORTHOTROPIC SHELLS OF REVOLUTION OF VARIABLE THICKNESS

MEDVEDEV, N. G. and PATELEYEV, A. D., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] The problem of stability of an orthotropic shell of revolution can be reduced to an eigenvalue problem $A\omega - \lambda B\omega = 0$, where A and B are some linear symmetric operators associated with the potential energy of deformation and the subcritical stressed state of the shell respectively. Associated with the lowest possible eigenvalue λ_1 of this problem is the critical load at which the shell loses stability, and associated with the corresponding eigenfunction $(\omega_1 = u_1, v_1, w_1)$ is the form of loss of stability. In this paper an examination is made of examples of spline calculations of critical loads and forms of loss of stability in the case of cylindrical shells of constant and variable thickness under axial compression when the boundary conditions $u = v = w = 0$ or $u = w = \frac{\partial w}{\partial z} = 0$ are satisfied on the ends. It is shown that the assumption of axisymmetric form of loss of stability generally leads to incorrect results in problems of stability and optimality of shells of variable thickness under axial compression. Figures 3; references: 4 Russian.
[5-6610]

RESPONSE OF A CYLINDRICAL SHELL LOCATED IN A TRANSVERSALLY ISOTROPIC MEDIUM TO THE ACTION OF A MOVING LOAD

POZHUYEV, V. I., Dnepropetrovsk Mining Institute

[Abstract] The author considers the problem of an axisymmetric moving load acting on a thin infinitely long cylindrical shell located in a transversally isotropic medium. It is assumed that the load moves at a constant velocity inside the shell and acts in the direction normal to the surface of the shell. The velocity of the load is taken as less than the rate of propagation of shear waves in the medium. The axis of the cylinder coincides with the axis of anisotropy of the medium. Sliding contact is assumed between the shell and the cavity in the medium, with connection on two sides. The response of the shell to the load is considered, and an analysis is made of the effect that anistropy of the medium has on the critical velocity and on the distribution of displacements and stresses. The problem is reduced to simultaneous integration of equations of motion of the medium and the shell when the conditions of contact are satisfied. Calculations were done for sandstone, limestone and basalt as approximately transversally isotropic media interacting with a steel shell through which an annular concentrated load was moving. Figures 3; references 9: 8 Russian, 1 Western.
[4-6610]

INVESTIGATION OF NONLINEAR OSCILLATIONS OF A SANDWICH SHELL CARRYING A MOVING INERTIAL LOAD

KOLESNIK, I. A. and IMANKHODZHAYEV, Ch. U., Dnepropetrovsk Metallurgical Institute

[Abstract] This paper was delivered at the Conference on Problems of Nonlinear Oscillations of Mechanical Systems held in Kiev, 18-20 October 1978. The authors consider transverse oscillations of a geometrically nonlinear mildly sloping sandwich shell with hinged edges bearing a moving inertial load of giv   h. This load moves at constant velocity parallel to one of the sides of the shell. A formula is derived for steady-state oscillations of a three-layered plate, and numerical calculations are done for a cylindrical panel made up of layers of duralumin, steel and viniplast. Curves are given showing the critical velocity as a function of the ratio between the masses of the shell and of the distributed load per unit of surface, and also for the frequency of natural oscillations of the fundamental tone as a function of load velocity with consideration of linear and nonlinear vibrations. Figures 3; references: 7 Russian.
[4-6610]

STABILITY OF STRINGER-STIFFENED SHELLS IN THE INHOMOGENEOUS STRESSED AND STRAINED STATE

GAVRILENKO, G. D., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] A method is proposed for numerical stability calculation of stringer-stiffened cylindrical shells with consideration of the discreteness of placement of the ribs in the inhomogeneous linear and nonlinear subcritical stressed and strained state. The subcritical state is calculated by equations of mixed form of either linear or nonlinear type. The results are compared with stability calculations of analogous shells based on equations in displacements. The problem is formulated for a thin-walled cylindrical shell reinforced by stringers that have eccentricity relative to the middle surface of the skin. A given longitudinal compressive force acts on the ends of the shell, uniformly applied to the skin and the stringers. Stability is calculated by the net-point method, and cases of loss of stability are considered. An analysis is made of critical loads of stringer-stiffened shells in the linear and nonlinear subcritical states. It is found that consideration of the linear subcritical torqued state reduces the critical load for such shells. Figures 2; references 3: 2 Russian, 1 Western.
[4-6610]

ON FREE OSCILLATIONS OF LAMINAR CYLINDRICAL SHELLS OF ARBITRARY OPEN PROFILE

BESPALOVA, Ye. I., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] In designing shell structures that operate under conditions of dynamic loading it is important to know the nature of the perturbing force and the individual properties of the shell that determine possible modes of oscillations, and the corresponding natural frequencies. The general problem of frequency spectrum analysis subsumes two interrelated problems: qualitative investigation of structure on the one hand, and quantitative determination of all dynamic characteristics of the elastic structure of the shell on the other. This paper deals with solution of the latter problem, being a continuation of research on determining the frequencies and modes of free oscillations of elastic systems as applied to the class of thin cylindrical shells of arbitrary cross section. A multilayered cylindrical shell of rectangular platform is considered with arbitrary open piecewise-continuous directrix.

Hinged support is assumed at the straight edges. The component layers are taken as orthotropic, inhomogeneous along the directrix, and working without separation or slip. The only inertial forces considered are those due to translation movement of the structure. The layers may be made of materials with different densities, and may vary in thickness along the directrix. Examples are given of the solution of specific problems of determining the dynamic characteristics of such shells. Figures 2; references: 10 Russian.
[4-6610]

APPLIED THEORY OF OSCILLATIONS OF ANISOTROPIC LAMINAR SHELLS OF VARIABLE STIFFNESS

KUZNETSOV, N. D. and KARTASHOV, G. G., Kuybyshev Aviation Institute

[Abstract] A theory of oscillations of shells of variable stiffness is developed on the basis of Reissner's approach [see E. Reissner, "On a Variational Theorem in Elasticity," JOURNAL OF MATHEMATICS AND PHYSICS, Vol 29, No 2, 1950, pp 90-95]. The analysis is based on a laminar shell of variable thickness $2h(\alpha_1)$ in an orthogonal system of curvilinear coordinates α_1, z, the coordinates α_1 = const being gaussian coordinates of the middle surface z = 0. It is assumed that the material of each layer of the shell conforms to generalized Hooke law, and that conditions of rigid contact are satisfied on the boundaries of the layers. Expressions are derived for stresses and displacements as well as resultant strains with the application of forces to the structure for given boundary conditions. Figure 1; references 7: 6 Russian, 1 Western.
[4-6610]

ON DETERMINING THE NATURAL FREQUENCIES OF OSCILLATIONS OF SHELLS OF REVOLUTION

KITAYGORODSKIY, A. B., Institute of Mechanics, UkSSR Academy of Sciences

[Abstract] In finding frequencies and modes of oscillations of thin orthotropic laminar shells with variable parameters, the system of equations of motion with given initial and boundary conditions is reduced to an infinite sequence of generalized one-dimensional eigenvalue problems, after which each boundary value problem is numerically solved by a method involving analysis of a determinant obtained when the boundary conditions are met at a given point. In this article it is shown that this procedure can be used to get approximation of some lower natural frequencies without preliminary information on their distribution. Examples are given. References: 4 Russian.
[4-6610]

DYNAMIC BEHAVIOR OF A CYLINDRICAL SHELL WITH ATTACHED MASSES DURING HEATING

BUSLOV, Ye. P., Moscow

[Abstract] In studying the stressed and strained state of thin-walled shell structures that are subjected to intense short-term action, extensive use has been made of the simplest computational scheme: a shell with immobile index contour. From a practical standpoint, the author considers the question of the error resulting from using such a scheme for strength calculations of structures bearing rigid bodies on the edges with mass comparable to the mass of the shell. An analysis is made of the influence that movability of the index contour has on the parameters of the stressed and strained state of a homogeneous cylindrical shell with attached massive bodies on the end fases in the case of unsteady axisymmetric heating. An elastic multilayered shell is considered that undergoes no deformations before heating. The time of heating and final temperature as well as the temperature field at each point are known. The model of the shell is made up of a given number of orthotropic layers that remain elastic during deformation and that work together without slipping. It is assumed that the hypotheses of the classical theory of thin shells are valid for the entire multilayered structure. The problem is numerically solved on the basis of an implicit finite-difference approximation of the equations of motion in displacements. Results of calculation are given for a two-layer cylindrical shell with

masses on the edges, assuming uniform heating of the layers. It is shown that the influence of the attached masses decreases with more rapid heating. The difference in the conditions of fastening of the shell becomes appreciable as the heating time increases. Figures 2; references: 5 Russian.
[4-6610]

SPATIAL OSCILLATIONS OF TWO COUPLED SOLIDS DUE TO IMPACT FORCES THAT ARISE AT CONTACT WITH NON-ZERO INITIAL VELOCITIES

GROBOV, V. A., deceased, and BULAKA, V. S., Kiev Construction Engineering Institute

[Abstract] An examination is made of spatial oscillations of a free system of two bodies with nonholonomic coupling between them when they are subjected to shock pulses that arise at the instant of contact with non-zero relative angular and linear velocities. It is assumed that a shock arises upon first impact, causing an instantaneous change in the linear and angular velocities of the bodies before any changes occur in the relative positions or orientation. It is shown that after a noncentral collision the system of bodies will undergo rotational-vibrational motions, turning about the axis perpendicular to the plane passing through their centers of mass with calculated periodically changing angular velocities. The angular motions are harmonic oscillations. Figures 2; references: 3 Russian.
[4-6610]

STRESSES IN BENT PIPES UNDER THE ACTION OF INTERNAL PRESSURE

KHAZHINSKIY, G. M., candidate of technical sciences, VNIImontazhspetsstroy

[Abstract] The main factor that determines the strength of bent pipes under cyclic
loading by internal pressure is the residual ellipticity of the cross section. Pre-
vious analysis has shown that deviations from true circular shape are complicated
and can be represented by a Fourier series. The author determines the main law of
distribution of deviations from circular shape by solving the problem of change in
shape of the cross section of a pipe during contained bending. The problem is re-
duced to calculation of a half-ring with known behavior of the elastic modulus. The
solution gives expressions for the distribution of bending moments and radial dis-
placements. It is shown that after bending in a groove without ovalization of the
cross section, the moment on the outside of the bend that arises under the action
of internal pressure is 4 times as high as in an oval pipe with the same ellipticity.
An expression is derived for normalized geometric ellipticity that defines the maxi-
mum annular bending stresses that arise in a bent pipe under the action of internal
pressure. Figures 4; references: 4 Russian.
[6-6610]

TESTING AND MATERIALS

EXTENDING THE SERVICE LIFE OF CRANKSHAFTS IN LOCOMOTIVE, STATIONARY AND MARINE
DIESELS

ZHUK, Ye. I., candidate of technical sciences, All-Union Scientific Research Insti-
tute of Diesel Locomotives

[Abstract] The author discusses research that has been done at the All-Union Scien-
tific Research Institute of Diesel Locomotives since 1960 on improving reliability
of various types of crankshafts. A description is given of machines developed at
the institute for fatigue testing crankshafts with the application of bending and
torsional loads. Strength and rigidity studies have been done on the crankshafts
of locomotive diesel engines type D100 (10DN20.7/2x25.4), 11D45 (16DN23/30), D49
(16ChN26/26), D70 (16ChN24/27) and PD1M (6ChN31.8/33) as well as stationary and
marine diesels G66 (6Ch36/45), G72 (6ChN36/45 and 6ChN30/38). A description is given
of machines for fatigue testing crankshafts during bending with programmable symmet-
ric and asymmetric cycles, and with twisting in a loading frequency range of 5-20 Hz.
The basic part of these machines is an oscillatory system comprising two welded load-
ing masses and the tested shaft. Some steps that have been taken to reduce wear and
breakage of engine crankshafts include modification of the crankcheeks to increase
bending pliability and improve stress distribution, redesign of oil-feed channels,
increasing the radius of hollow chambers in the transition from journal to crank-
cheeks, nitriding and cold-rolling, increasing the width of bearings by reducing
the length of fillet sections. Figures 4; references 4: 3 Russian, 1 Western.
[19-6610]

ALUMINUM-BASED PISTON ALLOYS

PLATONOV, V. N., PROZOROV, V. P., candidate of technical sciences, and PORSHNEV,
Yu. S., engineer, Central Scientific Research Diesel Institute

[Abstract] A comparative evaluation is made of some physico-mechanical, technologi-
cal and operational characteristics of aluminum piston alloys based on data in the
literature and research by the authors. The analysis covers grades AK4, AK4-1, AK6,
AL1 AL10V, PS-12, AL30, AL25, A32, AL26 and AK21. The mechanical properties measured
in tests are presented as tables. It is concluded that the best material for cast
aluminum pistons is silumins of the AL25 type [West German analogs Mahle-124, Mahle-
138, KS1275 and KS1275S]. Alloys with high silicon content (16-18%) should be used
in view of severe conditions of wear and high working temperatures. The strength of
aluminum-silicon alloy pistons can be increased by replacing casting with squeeze-
casting and hot-molding methods. Cyclic heat treatment is preferable to aging or
quenching with aging to increase the strength of piston blanks. Aluminum-silicon
alloys are superior to deformable aluminum-copper-magnesium alloys for highly loaded
pistons, but with the use of pressure working and other methods of increasing strength
when making the piston blanks. Deformable silumins are on the same strength level
with alloys of the AK4 type [U. S. analog Alcoa 2181] and at the same time have bet-
ter strength retention at elevated temperatures, wear resistance, and stability of
structure and properties with time and at high temperatures. References 7: 4 Russian,
3 Western.
[19-6610]

HIGH-TEMPERATURE STRENGTH CHARACTERISTICS OF CAST TITANIUM ALLOYS

PROZOROV, V. P., PODPALKIN, A. M., candidates of technical sciences, and BRONTVEYN,
M. M., engineer, Central Scientific Research Diesel Institute

[Abstract] An investigation was made of the long-term and fatigue strength of VT5L,
TS5L and VT3-1L cast titanium alloys at temperatures of 100-500°C. All the alloys
showed decreasing long-term strength with increasing temperatures as the testing
time is prolonged. Even at 500°C the long-term strength of VT3-1L alloy is 490 MPa
after 100 hours, and 450 MPa after 1000 hours, which is much better than the strength
of aluminum alloys at room temperature. The long-term strength of VT5L and TS5L

alloys at 400°C is also on an acceptable level. The fatigue tests were done on smooth specimens of VT5L and VT3-1L alloys at 100, 200 and 300°C on the VU-8 testing machine. The fatigue limit averages about 250 MPa over the entire temperature range for VT3-1L alloy, and decreases from 250 to 200 MPa with increasing temperature for VT5L alloy. Figures 3; references: 3 Russian.
[21-6610]

CONCERNING HEAT RELEASE ACCOMPANYING ELECTROELASTIC RADIAL OSCILLATIONS OF PIEZO-CERAMIC DISKS

KIRICHOK, I. F., Institute of Mechanics, UkSSR Academy of Sciences, Kiev

[Abstract] An investigation is made of electromechanical behavior and self-heating of piezoceramic disks accompanying electroelastic radial oscillations. An approach based on S. K. Godunov's method of discrete orthogonalization is used to solve the problem of electroviscoelasticity. A finite-difference method is used to solve the equation of thermal conductivity with a heat source. The analysis is based on consideration of a circular piezoceramic disk polarized along the radius with the outer surface interacting with an ambient acoustic medium, while the inner surface is free of stresses. The radial surfaces are totally covered by electrodes carrying a potential difference that varies harmonically in time. It is assumed that convective heat exchange with the ambient medium is identical on the end faces of the disks. Temperature is taken as invariant with respect to thickness. It is further assumed that the dynamic response of the disk is unaffected by the rapidly damped transient process, and that the vibrational heating is not influenced by the rate of increase in free energy and thermal stresses. The problem is reduced to solution of ordinary differential equations. Figures 3; references: 4 Russian.
[5-6610]

EFFECTIVE COEFFICIENTS OF ELECTROMECHANICAL COUPLING OF PIEZOCERAMIC BODIES

ARONOV, B. S., Leningrad

[Abstract] An energy method of calculating oscillations of piezoceramic bodies is used to determine the configuration and nature of connection of electrodes to maximize the effective coefficient of electromechanical coupling of piezoceramic bodies. The analysis shows that sectionalized transducers provide an increased coefficient of electromechanical coupling. In the unsectionalized transducer, when the external electric field strength is lengthwise constant a common current flows in all sections of the transducer, so that the same electrical energy is observed in all sections regardless of their contribution to electromechanical conversion. With sectionalizing, the inner sections of the transducer distribute currents in accordance with the average strains of each section, and the smaller the sections, the greater will be the correspondence of electrical energy to the contribution of a given section to conversion. Figures 5; references 3: 2 Russian, 1 Western.
[5-6610]

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